Dysphagia-related acute stroke complications: A retrospective observational cohort study

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Objectives: Post-stroke dysphagia is associated with aspiration pneumonia, but strategies intended to mitigate this complication, such as oral intake modifications, may unintentionally lead to dehydration-related complications such as urinary tract infections (UTIs) and constipation. This study aimed to determine the rates of aspiration pneumonia, dehydration, UTI and constipation in a large cohort of acute stroke patients and the independent predictors of each complication. *Materials and methods:* Data were extracted retrospectively for 31,953 acute stroke patients admitted to six hospitals in Adelaide, South Australia over a 20-year period. Tests of difference compared rates of complications between patients with and without dysphagia. Multiple logistic regression modelling explored variables that significantly predicted each complication. *Results:* In this consecutive cohort of acute stroke patients, with a mean (SD) age of 73.8 (13.8) years and 70.2% presenting with ischaemic stroke, rates of complications were: aspiration pneumonia (6.5%); dehydration (6.7%); UTI (10.1%); and constipation (4.4%). Each complication was significantly more prevalent for patients with dysphagia compared to those without. Controlling for demographic and other clinical variables, the presence of dysphagia independently predicted aspiration pneumonia (OR=2.61, 95% CI 2.21-3.07; p<.001), dehydration (OR=2.05, 95% CI 1.76-2.38; p<.001), UTI (OR=1.34, 95% CI 1.16-1.56; p<.001), and constipation (OR=1.30, 95% CI 1.07-1.59; p=.009). Additional predictive factors were increased age and prolonged hospitalisation. *Conclusions:* Aspiration pneumonia, dehydration, UTI, and constipation are common acute sequelae of stroke and independently associated with dysphagia. Future dysphagia intervention initiatives may utilise these reported complication rates to evaluate their impact on all four adverse health complications.

Keywords: Stroke—Dysphagia—Aspiration pneumonia—Dehydration—Urinary tract infection—Constipation—Hemiparesis—Cohort study

Introduction

Dysphagia, or impaired swallowing, is reported to affect between 8.1% and 45.3% of patients following stroke.[1] Dysphagia is associated with longer length of stay (LOS) in acute hospital, increased healthcare costs, and greater long-term institutionalisation.[2,3] Aspiration pneumonia mediates a significant proportion of this deleterious association and, in its own right, is associated with increased length of stay in hospital,[4] poorer post-stroke functioning,[5,6] and increased mortality.[7]

Given these negative outcomes, recommendations to prevent aspiration pneumonia feature prominently in clinical stroke guidelines internationally.[8-11] However, there is growing concern that strategies prescribed to

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Received February 25, 2023; revision received April 2, 2023; accepted April 3, 2023.

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1052-3057/$ - see front matter

https://doi.org/10.1016/j.jstrokecerebrovasdis.2023.107123

manage aspiration among patients with dysphagia, such as dietary and fluid modification, may unintentionally lead to inadequate fluid intake and related consequences such as dehydration.[12] Dehydration, itself, is associated with higher healthcare costs, poorer functioning and increased mortality and predisposes patients to constipation, urinary tract infections (UTI) and falls.[13-16] In turn, these complications are associated with poor functional outcomes and delayed recovery.[5,16-20] However, in contrast to aspiration pneumonia, there is relatively limited evidence regarding the prevalence of these complications in the acute stroke population and how strongly dysphagia is associated with these complications. Previous observational studies of these other complications, whilst prospective, have been conducted in single sites and/or with small sample sizes.

Aims and/or hypotheses

The present study sought to clarify the rates of aspiration pneumonia, dehydration, UTI and constipation in a large consecutive cohort of acute stroke patients, and to determine whether they are independently associated with dysphagia, and the strength of such an association, if present. We hypothesised that dysphagia would independently predict all four complications, irrespective of whether it was present in isolation or in combination with other stroke comorbidities, particularly hemiparesis, as a result of a more severe stroke.

Methods

This retrospective observational cohort study was undertaken across six public hospitals in metropolitan Adelaide. Data were extracted from the Integrated South Australian Activity Collection (ISAAC), which contains de-identified data for all patients separated from every public and private acute South Australian hospital since 1985.[21] Diagnoses were coded according to the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM).[22] Ethical and governance approvals were granted by SA Department for Health and Wellbeing (HREC/18/SAH/114), which included a waiver of the requirement for individual consent. The study was designed and reported on according to the STROBE checklist for observational studies.

Purposive sampling identified 31,953 consecutive patients or 'hospital separations', over a 20 years between financial years 2000-2001 to 2019-2020, which met the following inclusion criteria: aged 18 years or over; admitted to one of six South Australian metropolitan hospitals accepting the majority of metropolitan acute admissions during this 20-year period; with an 'acute' episode of care for a primary ICD-10-AM acute stroke code (intracerebral haemorrhage (ICH; I610-I619); intracranial haemorrhage, non-traumatic unspecified (I629); cerebral infarction ('ischaemic stroke'; I630-I639); or stroke not specified as haemorrhage or infarction (I64)). We excluded diagnoses of subarachnoid haemorrhage (I600-I609), non-traumatic subdural haemorrhage (I620) and non-traumatic extradural haemorrhage (I621) as these cases are not typically treated in stroke units according to stroke care pathways.

Data extraction

For each patient, demographic and clinical data were extracted (sex, age at admission, length of hospital stay (LOS), hospital of admission, financial year of separation, stroke type, and the occurrence of in-hospital death). Each patient's Charlson Comorbidity Index (CCI)[23] was also calculated from their coded ISAAC diagnoses as a measure of functional outcome and risk of mortality.[24,25]

The dependent variables were the post-stroke complications of interest: aspiration pneumonia (J690), dehydration (E870), UTI (N390), and constipation (K590). A code of 0 ('absent') or 1 ('present') was assigned for each complication according to whether it appeared as a diagnosis during their ISAAC separation.

Data were also extracted regarding the presence or absence of dysphagia (R13) and hemiparesis (G819) as comorbidities, in order to stratify patients into three independent groups of interest: i. patients presenting with both dysphagia and hemiparesis (the 'dysphagia and hemiparesis' group), ii. patients with dysphagia, but not hemiparesis (the 'dysphagia only' group), and iii. patients without dysphagia, with or without hemiparesis (the 'no dysphagia' group). This stratification was designed to enable accurate estimation of the impact of dysphagia itself, separate from the impact of a severe total anterior circulation stroke.[26]

Data analysis

Descriptive statistics were used to present the demographic profile and rates of the complications of interest, as *n* (%), in each of the three subgroups of patients of interest. Differences in complication rates between patient groups were analysed using tests of difference (analysis of variance and chi-square tests),[27] and z-tests with Bonferroni corrections were used post-hoc to determine the nature of any significant effects.[28]

Subsequently, all independent, demographic, and clinical variables were assessed for the strength of their relationship with each complication using univariate analyses. Length of stay was stratified into five groups (1 to <3 days, 3 to <7 days, 7 to <14 days, 14 to <28 days, and 28 days or over) for ease of interpretation. Univariate analyses are presented in supplementary material. Variables significantly associated with each complication in univariate analysis were entered into multivariate regression modelling to assess their independent contribution to the odds of developing each complication, presented as an odds ratio (OR).[29] Area Under the Receiver Operating

Characteristic Curve statistics were calculated to indicate each model's 'goodness-of-fit'.[30] Full results of each logistic regression analysis are presented as Supplementary material. All analyses were conducted in IBM SPSS Statistics (version 25.0) and Stata Statistical Software (version 16.0).[31]

Results

Patients' demographic and clinical characteristics are presented in Table 1. Of the 31,953 acute stroke episodes, 70.2% were coded as ischaemic stroke, 17.3% as ICH and 12.6% unspecified. Mean age was 73.8 years (SD 13.8). Post-stroke dysphagia affected 21.1% of patients, of which 15.1% experienced both dysphagia and hemiparesis and 6.0% presented with dysphagia only.

Table 1. *Demographic and Clinical Characteristics of the Stroke Cohort*

Characteristic	n (%)
Total no. Stroke Patients	31,953 (100)
Male	17,018 (53.3)
Stroke Type	
Haemorrhage (I61.0-I61.9 or I629)	5,521 (17.3)
Infarction (I63.0-I63.9)	22,417 (70.2)
Unspecified (I64)	4,015 (12.6)
Mean age in years (SD)	73.8 (13.8)
Mean LOS in days (SD)	10.4 (14.4)
CCI Score	
1	8,937 (28.0)
≥2	23,016 (72.0)
Dysphagia	6,729 (21.1)
Hemiparesis	16,509 (51.7)
Dysphagia/Hemiparesis Category	
Dysphagia and Hemiparesis	4,822 (15.1)
Dysphagia Only	1,907 (6.0)
No Dysphagia	25,224 (78.9)
In-Hospital Death	4,411 (13.8)

Note. LOS = Length of Stay; CCI = Charlson Comorbidity Index.

Rates of complications in the stroke cohort

Aspiration pneumonia (n=2,075, 6.5%) and dehydration (n=2,144, 6.7%) affected similar proportions of the cohort. UTI was the most common of the four complications (n=3,220, 10.1%), whereas constipation affected the fewest stroke patients (n=1,419, 4.4%).

Rates of complications in the presence of post-stroke dysphagia

Examining the three subgroups stratified according to the presence of dysphagia and hemiparesis, rates of aspiration pneumonia, UTI, and constipation were significantly higher in patients with both dysphagia and hemiparesis, representative of a more severe stroke, than in patients with dysphagia alone. Rates in both groups were higher than in patients without dysphagia (Figure 1). This pattern was not observed for dehydration. Similar rates of dehydration occurred among those with dysphagia and hemiparesis (12.8%) and those with dysphagia only (13.8%); both groups had significantly higher rates of dehydration than those without dysphagia (5.0%; Figure 1).

Multivariable complication associations

Figure 2 summarises the significant predictors and protective factors for each complication in order of the magnitude of the ORs. The strongest predictor of all complications in this stroke cohort was LOS (28 days or over > LOS of 14 to <28 days.) Male sex was a significant risk factor for aspiration pneumonia but was a significant protective factor for dehydration and UTI. Greater CCI was significantly associated with aspiration pneumonia, dehydration, and UTI. Increased age was also associated with all complications but was consistently the weakest predictor in each model.

The presence of dysphagia alone was independently associated with all complications; aspiration pneumonia (OR=2.61, CI 2.61-2.77; p<.001), dehydration (OR=2.05, CI 1.76-2.38; p<.001), UTI (OR=1.34, CI 1.16-1.56; p<.001)

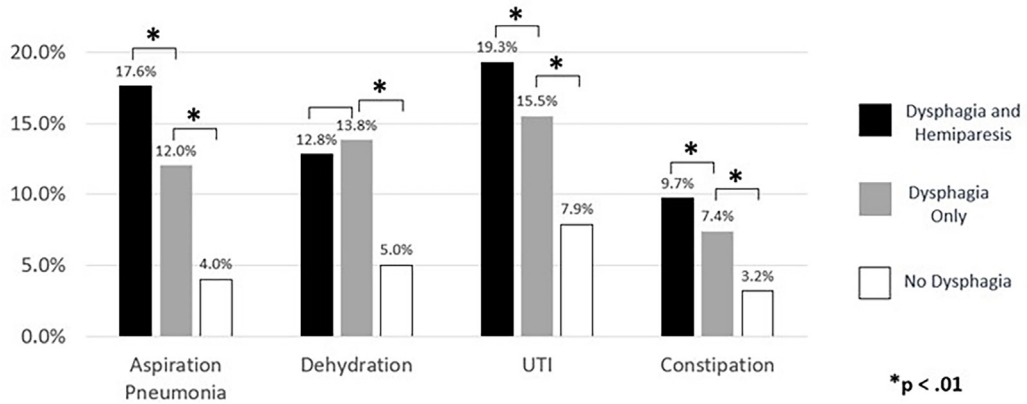

Fig. 1. *Comparison of the Rates of In-Hospital Medical Complications Among Hospitalised Acute Stroke Patients With and Without Dysphagia*

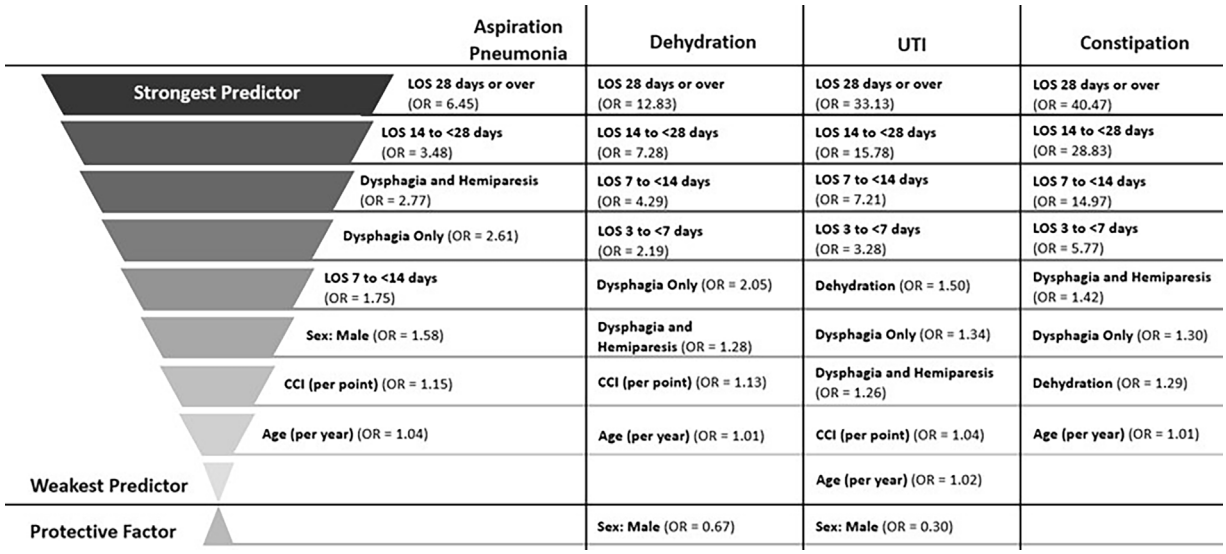

Fig. 2. *Summary of Regression Analyses in the Acute Stroke Cohort*

and constipation (OR=1.30, CI 1.07-1.59; p=.009; Figure 2). The presence of both dysphagia and hemiparesis, representative of a more severe stroke, was also significantly associated with all complications; it was a stronger predictor of aspiration pneumonia and constipation than dysphagia only, but a weaker predictor of dehydration and UTI than dysphagia only. Dehydration was independently associated with both UTI (OR=1.50, CI 1.33-1.70; p<.001) and constipation (OR=1.29, CI 1.10-1.51; p=.002; Figure 2).

Discussion

Our study uniquely reports rates of four common complications in one large cohort of acute stroke patients and explores their association with dysphagia and other predictive clinical factors. Findings confirm that patients with dysphagia are more likely to develop the adverse complications of aspiration pneumonia, dehydration, UTI and constipation than those without dysphagia, and that dysphagia itself is an independent predictor of all four complications, irrespective of the severity of the stroke.

Complication rates

The rate of UTI of 10.1% reported here aligns closely with two prior systematic syntheses, which reported UTI rates between 7.9% and 10% in this population.[32,33] In contrast, the rate of aspiration pneumonia of 6.5% in this study was lower than the pooled pneumonia rates of 10% to 12.3% reported in previous meta-analyses.[32,33] This discrepancy likely reflects methodological differences, with these meta-analyses citing rates of respiratory infections of all aetiologies. In this study, we only examined *aspiration* pneumonia as the ICD-10-AM code J690 is only assigned if medical record coders have sufficient information to attribute a patients' infection to the aspiration of food or gastric contents.[22]

Similarly, our data demonstrated a dehydration rate of 6.7%, which is lower than the range of 29% to 70% reported in a sytematic review.[34] This discrepancy is likely also related to differing methodological approaches to outcome measurement by the authors of the primary studies within that systematic review, with measures of dehydration ranging from blood urea nitrogen to creatinine ratio, serum osmolality and bioimpedance. While these measures are valid biomarkers, they are still considered imperfect measures, and studies define dehydration according to differing threshold values.[12,34,35] In this study, the classification of dehydration was based on complex and multifactorial diagnoses made within South Australian acute health facilities, typically considering patient history, clinical symptoms, fluid balance, and blood and urine analysis.[36] Coders will only allocate an ICD-10 AM diagnosis if there is unequivocal evidence of the documented condition.[22] The multifactorial approach to diagnosing constipation encoded in our data therefore likely also led to a lower rate (4.4%) compared to a meta-analysis reporting 45%.[37] Examining rates of clinical diagnoses by coding is less sensitive but more specific and has likely resulted in the lower complication rates in the current study but potentially more accurate estimations of complications than those reported previously.

Whilst the raw data from this study were extracted from a single state in Australia, the cohort of patients was large at just under 32,000 and had demographic and clinical characteristics typical of stroke populations in developed countries,[38] hence rates of complications are likely to be generalisable across countries with similar health services.

Rates of complications alert us to the size of the problem, and multiple regression modelling allowed us to

determine more accurately the variables that predicted the complications, thereby potentially directing management strategies.

Predictive factors - dysphagia

Multivariate analyses confirmed that dysphagia alone was a significant predictor of all complications and was most strongly associated with aspiration pneumonia and dehydration, followed by UTI and constipation. These findings are consistent with several previous studies identifying dysphagia as an independent predictor of post-stroke pneumonia, with similar ORs between 1.89[39] and 3.35.[40] Further, our results strengthen the evidence for previously reported *univariate* associations between dysphagia and dehydration,[41] and between dysphagia and constipation in stroke cohorts.[42] This study also confirms the association between dysphagia and UTI among stroke patients, which had previously only been examined in a heterogeneous hospital population.[43]

Of interest is the impact of both dysphagia and hemiparesis, used in our study as a proxy for severe stroke, which was a significant predictor of all complications. These patients may have greater functional dependence for feeding/drinking and maintaining oral hygiene,[44] poorer sitting balance and mobility,[45] poorer lung function and cough response,[46] and are more likely to require urinary catheterisation.[47] Interestingly, the presence of both dysphagia and hemiparesis, representative of a more severe stroke, was a weaker predictor of dehydration and UTI than dysphagia alone. Therefore, it likely that, although the presence of a severe stroke significantly contributes to these complications, dysphagia is the more powerful predictive factor.

These results may have important implications for dysphagia management. Although the current study cannot provide causation, our findings lend weight to existing literature suggesting an association between inadequate fluid and/or fibre intake and dehydration, in patients with dysphagia who are prescribed texture-modified diets and fluids.[12,48,49] Similar associations have been reported for inadequate fluid intake and UTI[13,14,48] and constipation.[50] Concern about the overuse of thickened liquids in elderly patients with dysphagia is growing, particularly with the limited evidence for their effectiveness but increased risk of dehydration.[51-53] Therefore, we propose that the unintended consequences of dysphagia management when using modified diets and thickened fluids should be carefully considered in order to avoid all of the complications evaluated here, rather than solely focussing on the prevention of aspiration pneumonia.

Other predictive factors

Beyond dysphagia and hemiparesis, the current study identified additional factors that significantly predicted each complication studied here; namely, age, sex and length of hospital stay. Consistent with previous literature, older patients were at higher risk of all complications,[35,39,54-56] and those with a greater number of comorbidities were more likely to develop aspiration pneumonia, dehydration, and UTI.[47,57,58] Additionally, this study confirmed prior reports that male sex is a risk factor for aspiration pneumonia,[59] and a protective factor for dehydration and UTI.[35,55] Prolonged LOS beyond 14 and 28 days most strongly predicted all complications among stroke patients, supporting previously reported associations.[4,35] It is possible that patients with more severe strokes are less medically stable, requiring extended hospitalisations and increasing the risk of these complications. Alternatively, the increased care requirements associated with developing these complications may have contributed to their longer LOS. These findings will be of interest to healthcare professionals and managers aiming to maintain patient throughput and cost efficient stroke services.[60]

Implications for clinical practice and research

As acute stroke patients with dysphagia are at increased risk of these complications, early swallow screening and assessment is crucial for identifying all patients with dysphagia. This is in line with Australian and international guidelines,[8-11] but additionally, these patients may require close monitoring of respiratory function, hydration, and continence. Although stroke guidelines currently highlight the risks of aspiration pneumonia and dehydration, the inclusion of written protocols for hydration *management* are long overdue.[61] Further, recommendations emphasising the importance of monitoring and managing bladder and bowel function in this patient group may also help to promote improved health outcomes. Future intervention studies in stroke may utilise the baseline rates of aspiration pneumonia, dehydration, UTI, and constipation provided in this study to evaluate the impact of evidence-based preventative strategies on all adverse health complications (wider than aspiration pneumonia).

Limitations

Our study had several limitations: as a retrospective observational study, we were unable to verify the accuracy of the ISAAC data; however, agreement between actual clinical diagnoses and coded data have been found to be excellent for stroke, dysphagia, and aspiration pneumonia in this database.[62] In fact, with the stringent documentation requirement for the coding of dehydration and constipation, it is possible that these complications were under-represented. It was not possible to determine the timing of complication onset during each hospitalisation, therefore, complication onset may have occurred just prior to hospitalisation in some instances. The complications examined in this study are highly multifactorial, and

it is unlikely that all contributing factors were identified and included in the regression models. In particular, stroke severity (i.e., as measured by the National Institute of Health Stroke Scale) was not quantified except by the proxy measure of hemiparesis. Finally, although the stroke cohort had clinical characteristics typical of stroke populations, our findings should be interpreted in the context of the Australian healthcare system and may not be generalisable to other acute stroke populations and healthcare systems.

Conclusions

Through the retrospective analysis of comprehensive hospital separations data, this study revealed complication rates for stroke patients hospitalised during the past two decades of aspiration pneumonia (6.5%), dehydration (6.7%), UTI (10.1%), and constipation (4.4%). All complications were independently predicted by the presence of dysphagia. This research highlights the need for careful multi-pronged monitoring and management of patients with dysphagia throughout their acute care journey. Evaluation of the potential impact of current and alternative dysphagia management practices on these complications is warranted.

Department and institution where work was performed

Flinders University, Adelaide, Australia

Grant support

None

Sources of funding

This research did not receive any funding from public or private entities, individuals, or commercial or institutional support

Data availability statement

Extracted and analysed data can be made available pending ethical approval by contacting the corresponding author.

Declaration of Competing Interest

The authors report no conflicts of interest.

Acknowledgments: The authors gratefully acknowledge Mr Paul Hakendorf for contributions in extracting patient data and regression modelling, and Professor Richard Woodman for providing statistical advice.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jstrokecerebrovasdis.2023.107123.

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